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*Published in:*  
Water Resources Management

*DOI:*  
[10.1007/s11269-014-0629-8](https://doi.org/10.1007/s11269-014-0629-8)

**IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.**

*Document Version*  
Publisher's PDF, also known as Version of record

*Publication date:*  
2014

[Link to publication in University of Groningen/UMCG research database](#)

### *Citation for published version (APA):*

Hijdra, A., Arts, J., & Woltjer, J. (2014). Do We Need to Rethink Our Waterways? Values of Ageing Waterways in Current and Future Society. *Water Resources Management*, 28(9), 2599-2613.  
<https://doi.org/10.1007/s11269-014-0629-8>

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# Do We Need to Rethink Our Waterways? Values of Ageing Waterways in Current and Future Society

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Received: 31 December 2012 / Accepted: 15 April 2014 /

Published online: 27 April 2014

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**Abstract** In the past canals were developed, and some rivers were heavily altered, driven by the need for good transportation infrastructure. Major investments were made in navigation locks, weirs and artificial embankments, and many of these assets are now reaching the end of their technical lifetime. Since then the concept of integrated water resource management (IWRM) emerged as a concept to manage and develop water-bodies in general. Two pressing problems arise from these developments: (1) major reinvestment is needed in order to maintain the transportation function of these waterways, and (2), it is not clear how the implementation of the concept of IWRM can be brought into harmony with such reinvestment. This paper aims to illustrate the problems in capital-intensive parts of waterway systems, and argues for exploring value-driven solutions that rely on the inclusion of multiple values, thus solving both funding problems and stakeholder conflicts. The focus on value in cooperative strategies is key to defining viable implementation strategies for waterway projects.

**Keywords** Waterways · Ageing assets · Value creation · IWRM · Inland navigation

## 1 Introduction

Waterways are navigable waters, such as rivers, canals and lakes. These waterways have often been altered or developed for transportation purposes. The purpose of navigation did not only alter the characteristics of waterways in the past, it will most probably persist in doing so in the future. In several western countries, investment waves in the past resulted in step-wise development of the navigation system. For instance the waterway systems in countries like Germany, France, United States and the Netherlands followed such a development.

Many of the assets in these systems, which have been build in the past, reach their end of technical lifetime or functional lifetime due to climate change or changed societal requirements. Projects to update, renovate or replace these assets can therefor be expected. Such assets must be replaced in order to maintain functionality. Typically, investments in these

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assets are optimized in terms of economic efficiency and fit the ‘predict and control’ paradigm in terms of hierarchical narrow focus governance and power delivery of massive centralized infrastructure elements by single sources of design (Pahl-Wostl 2007). Funding of such project is often earmarked for ‘transportation purposes’, not addressing the myriad of uses and values linked to these waters.

Since the 1970s the concept of integrated water resource management (IWRM) emerged as a concept to manage and develop water-bodies in general. This concept is widely adopted and advocated and promotes the inclusion of the variety of uses, aspects and values in managing water resources. In the practice of waterway management this leads to the following problematic issue:

- Based on the life expectancy of assets in inland waterway transport systems, and the reliance of the transport sector on these systems, a new wave of waterway infrastructure investments can be expected.
- Literature is unclear on how these major and long lasting investments are to be implemented taking into consideration the principles of IWRM. A viable strategy is needed.

Illustrative examples of these assets for navigation purposes are navigation locks, weirs or artificial bank protection like steel sheetpile lining. The modification of these structures, if circumstances change or if they need to serve other functions than foreseen during design, is generally very expensive if not technically impossible (Pahl-Wostl et al. 2010).

If issues of ageing are not adequately addressed, users may experience direct or indirect consequences. Obviously this is true for all types of infrastructure like for instance railways and roads (Rogers et al. 2012). However, waterway infrastructure has a few distinctive characteristics compared to other transportation systems:

- Assets usually have long lifecycles (sometimes exceeding 100 years);
- Problems are less visible (underwater);
- Assets are capital intensive and strongly linked to the surrounding area due to connections to (other) open water and groundwater;
- The network serves multiple purposes;
- The network is vulnerable to failure due to a lack of alternative routes.

Literature on waterways as a transportation system, and the characteristic issues that come with that, is scarce, certainly considering such a system in the light of IWRM. In this paper we discuss this issue from the perspective of the Dutch practice. As a new wave of investments can be expected, it is important to develop a viable strategy to address the problematic state and challenges of these waterways. At the same time, the push for reinvestment can also be considered an opportunity to boost the meaning and relevance of these waterways for society.

## 2 Theory

In river and watershed management, a widely advocated paradigm for management and development of rivers is IWRM (Jøneh-Clausen 2004; Mount and Bielak 2011; UN Water and Global Water Partnership 2007; United Nations 2010; World Bank 2009, 2010). However, in literature IWRM has been criticized for the lack of translation of theory to action on the ground (Biswas 2004; van der Brugge and Rotmans 2007; Butterworth et al. 2010; Jeffrey and Gearey 2006).

The definition of IWRM has seen various formulations, the definition used by the United Nations –Water and the Global Water Partnership is formulated as follows (UN Water and Global Water Partnership 2007):

*‘A process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.’*

In this definition, maximizing the resultant economic and social welfare is mentioned. This general resultant is in fact a summation of many effects on a myriad of stakeholders related to the area concerned. The distribution of value among stakeholders determines whether these parties are interested in cooperating, co-investing, or competing. It therefore greatly influences stakeholder behaviour (Lax and Sebenius 1986; Raiffa 1982; Susskind et al. 1999). So in striving for maximization of the resultant economic and social welfare, it is key to keep a keen eye on the distribution of value in order to avoid resistance or obstruction in the implementation process.

### 3 Method

The emphasis on integrated waterway management, as well as on value, calls for attention to the rich and complex context of waterways. The Dutch situation is taken to illustrate this for two reasons; as it is a densely populated country balancing stakeholder issues is nearly always apparent, and secondly; it is part of a much wider waterway system, the north-western European system, which has been developed in similar pace, and therefore faces similar ageing problems.

The paper is based on a series of interviews with officers responsible for waterway development projects, review of a database of institutional and physical characteristics of waterway projects (i.e. the Rijkswaterstaat database) and gives an overview of the development and issues from this perspective. Then this information is condensed into a constructed case that is written as a story to illustrate how a focus on value, taking into account a multitude of stakeholders and interlinkages of issues could work. Stories are typically suited to such a purpose and can convey information in a compact form (Denning 2005; Gargiulo 2006). This method allowed the authors to visualize the problematic state of our waterways in an articulate way, and detail the dilemma of how to proceed with ageing waterways. This example illustrates how value creation, making transactions, capturing and sharing value can drive an implementation strategy that fits contemporary waterway management concepts such as IWRM. The elements used in the case have been selected according to recurring characteristics in the Rijkswaterstaat database. A four-step approach is used to construct the case:

**Step 1** From an operational list of Rijkswaterstaat waterway projects in planning or implementation phase, projects were identified in which pursuing value of some sort played a significant role. The criterion of significance was that the project had to include uses other than navigation itself. Table 1 shows the projects, which have been used.

In a desk study, the data were organized according to policy coordination, investment strategies for the projects themselves, the context of the project and ageing of the assets involved.

**Step 2** In-depth interviews were then conducted with the project managers, contract managers and stakeholder issue coordinators of these projects to explore the value opportunities

**Table 1** List of projects where other uses or values than navigation only played a significant role

Project	Included value(s) other than navigation
Maaswerken Project	Nature development, flood protection, mining of gravel and sand. Water supply through the Julianakanaal, recreation.
Twentekanaal enlargement	Improving Ecological quality of the embankments
New Lock at Eefde	Improved water management for both drainage and supply
Omlegging Den Bosch, 9 km of new canal	Wetlands, recreational values, aesthetics
Replacement of 7 locks at the Zuid-Willemsvaart	Water drainage, ecological quality
Third navigation lock Beatrixsluizen	Recreational and heritage values
Renovation and deepening of the Beatrixcanal	Improving ecological quality, recreation (slow-lane cycling paths)
Self Supporting River Systems (IJssel)	Biomass production at floodplains to recover costs of river management
Room for the River	Housing, aesthetics, ecology, flood protection and recreation.

that had been identified and the difficulties in capitalizing on these opportunities. The interviewees were selected on the basis of discussions with practitioners in the field. If value creation amongst stakeholders had been successful or seemed possible, the responsible officer was interviewed. In this round 10 officers were interviewed (Appendix 1) using a semi structured interview format (Appendix 2).

- Step 3 The ideas and data obtained in steps 1 and 2 were based on the experience of the Rijkswaterstaat organization. International valorization of these ideas and data took place in discussions with practitioners from the PIANC working group on values of waterways. PIANC, the Permanent International Association of Navigational Congresses, is a global organization providing guidance for sustainable waterborne transport infrastructure for ports and waterways. The waterway agencies of seven countries are represented in the PIANC working group: the Netherlands, USA, Egypt, France, Belgium, the United Kingdom and Germany. A series of eight meetings took place beginning in Sept 2010, up to September 2013. During these sessions, six to eight workshop participants from different countries were asked about policy coordination, investments, context and the use of value in waterway projects with which they were familiar.
- Step 4 In the last step the illustrative case was created—a fictional story—which was based on the projects and the data and ideas gathered in the previous steps. As explained above, the elements were selected for the story according to generic characteristics from the database.

Step 1, 2 and 3 are reflected in ‘Waterways management in the Netherlands’ (Section 4), step 4 is shown in ‘The Hoven Canal—Value as a driving implementation strategy’ (Section 5). In Section 6 the results are discussed and Section 7 shows the conclusions.

#### 4 Waterway Management in the Netherlands

The Netherlands has a system of around 6,500 km of waterways used for navigation. The smaller waterways are mostly used by recreational crafts, the main arteries by commercial vessels. Rijkswaterstaat is the agency responsible for these main arteries. These include the rivers Waal and Meuse, and several major canals. For navigation purposes a multitude of assets

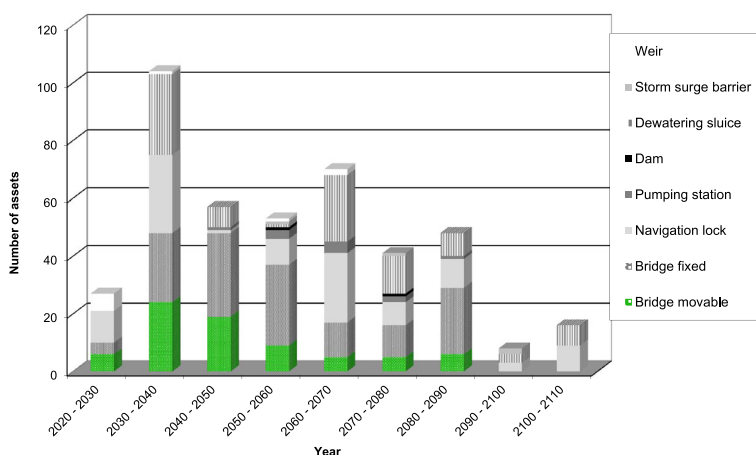
have been built in these waterways. Rijkswaterstaat is responsible management of these assets. Amongst these assets are for instance 10 weirs and around 120 lock chambers.

Figure 1 shows the prognoses of the end of lifetime of waterway structures for the Netherlands. The chart shows waterway-related assets that are the responsibility of the national government (Ministry of Infrastructure and the Environment 2012).

The figure shows that there will be a steep increase in the number of assets that will need replacing in the period from 2020 to 2040, given their design lifetime. Considering the significant preparation and implementation time required for these projects, timely planning is key. Preparations are currently being made for this in the form of national water strategies under the national Delta Programme and management strategies devised by Rijkswaterstaat (Ministry of Infrastructure and the Environment 2012).

Replacing navigation assets takes place in a different context from the one in which most waterway assets were originally created. There were traditionally only limited dealings with stakeholders when canals were being developed or rivers altered to serve the transportation industry. Furthermore, the environmental or social effects that needed to be taken into consideration were relatively limited. Contemporary projects, however, need to take into account a multitude of stakeholders and effects. As water has always played an important role in the development of societies, the interests and effects that need to be taken into account are often as numerous as they are diverse. Table 2 lists functions typically related to waterways. It is based on the international experiences of the members of the PIANC working group on values of waterways and was used as a guideline for group discussions (step 3 in the methodology section). The discussion revealed that the list is not exhaustive and it is difficult to attribute a clear outline to the selection. In this paper this list is used to give an impression of the complex relationship waterways can have with the surrounding area, institutions and stakeholders.

With this list in mind, and considering the interconnectedness of different functions and values, it can be argued that waterways have certainly become complex systems that cover social, environmental and economic areas. Complex systems are sensitive to such interconnectedness (Holling 2001). Adapting these waterways to face the challenges of modern society is therefore more complex than finding a straightforward solution to a single issue (Axelrod 1984).



**Fig. 1** Projected replacement moments for waterway-related assets of the Dutch national government. Replacement moments are based on year of commissioning and technical lifetime of the assets (Ministry of Infrastructure and the Environment 2012)

**Table 2** Functions and values of waterways (non-exhaustive). Source: PIANC working group 139, 2010

Functions and values of waterways			
Cargo transport	Irrigation	Flood protection	Ecology
Hydropower	Cooling water	Drinking water	Industrial process water
Ecosystem services	Water storage	Administrative border	Water drainage
Historical/heritage	Social coherence	Cultural identity	Religious values
Recreation at embankments	Passenger traffic	Water recreation	Military purposes
Landscape/aesthetics	Housing at or on the water	Fishing	

Since the waterway networks were completed, there have been dramatic social, technological and environmental changes (Filarski 2014). In the era of the transport revolution and network development (19th century) the major part of the system came in place. In the 1930s a major investment surge adapted and improved the system. A second interesting reference point is the period from 1950 to 1970, when large scale improvements and modifications were made in order to align the characteristics of the waterways with the requirements of the time (Filarski and Mom 2008). This entails not taking into account the vast majority of developments that have occurred since the 1970s and affected the major assets of the networks. It also means that the local situation determines whether developments dating back further are taken into account. Table 3 lists a selection of developments that were relevant to waterways using these time frames. A third column is added referring to a next investment surge due to required replacement of ageing assets.

It is not possible to capture all relevant changes in society and the economy in a single table. However, the main question that arises is what this list actually means for the current situation and the desired future situation. Exploring an example situation in depth would illustrate the trade-offs in more detail.

## 5 Story of the ‘Hoven Canal’—Value as a Driving Implementation Strategy

This example helps identify a new infrastructure investment strategy that might bring substantial benefits to a wider range of stakeholders because it employs a more integrated approach towards waterway redevelopment. The story begins by discussing typical generic attributes of a Dutch waterway before continuing by demonstrating the difference between two emblematic management strategies: a more traditional specialized approach and a value-oriented approach to waterway management.

### 5.1 History of the Canal

About a century ago, the town of Hoven faced several problems. Industry in the region was under severe pressure because the neighbouring town of Veld with its superior riverside location represented lower transportation costs. In addition, during periods of high rainfall, the farmland around Hoven was poorly drained, whereas in the summertime there was frequently a lack of sufficient irrigation water. Local politicians, in conjunction with industrial and agricultural leaders, launched a plan to improve the situation in Hoven. The key feature of their plan was to connect the region to the river with a new man-made, 40-km-long canal (Fig. 2). The canal would serve as a transportation corridor, a drainage canal in wet periods and an irrigation canal in times of drought. Construction started in the 1930s, creating work at a time of crisis and mass unemployment. The canal is suitable for CEMT class IV shipping,

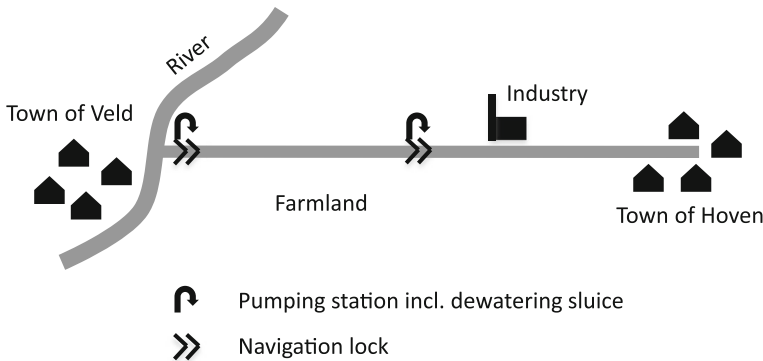
**Table 3** Historic and expected investment surges in waterway networks

Sector and society characteristics in early 19th century up to investment wave in the 1930s in Netherlands.	Sector and society characteristics in last major waterway investment period in the Netherlands (1950s to 1970s)	Sector and society characteristics in expected investment wave due to end of lifetime of many assets (present—to around 2040).
<u>Navigation</u> Transport by towing ships, diligence stage coaches, sailboats, horse and carriages Fine-mesh waterway network No open water dredging capability Rivers mostly in natural condition River and open water navigation unreliable due to weather conditions Canals provide reliability for transport Long-distance passenger travel mostly by water Shallow draft ships Emergence of steamships <u>Society and waterways</u> Widespread poverty Economy based on agriculture and crafts Industrialization Limited influence of cost-benefit analysis in government decisions Mature railway networks Emerging influence of global competition Urbanization Growing competition from railway	<u>Navigation</u> Deteriorated condition of waterway network Technological capability to dredge rivers and open water Emergence of push convoys of up to six units Decline in number of commercial inland vessels Economies of scale in inland transportation Fully motorized fleet Disappearance of towing convoys Introduction of on-board IT equipment Improved manoeuvring capability of ships Containerization of general cargo Improvement of productivity and safety <u>Society and waterways</u> Fast growing economy European seaport competition Railroad cargo transport no longer competitive with waterway transport Cost-benefit analysis for projects standard Small waterways obsolete for commercial use Emergence and growth of recreational navigation Importance of environmental issues Cultural heritage of waterways	<u>Navigation</u> Focus on multimodal or synchromodal transport Further growth of containerisation. Focus on fuel efficiency and emissions. Increased climate extremes Improved track, trace and travel planning. Further increase in recreational navigation Growth of average ship size as new vessels are mostly large, decommissioned vessels are mostly small. <u>Society and waterways</u> Climate change and adaptive measures to be taken around waterways. Sustainability, recycling, and closing the material loop as a key concept in construction. Decarbonisation of transport. Integrated view on waterways by the general public and growing participation of public and/or stakeholders. Strict ecologic legislation to take into account in waterway development.

Selection of relevant characteristics at the historic moments of investment in the Netherlands by Filarski and Mom (2008) and Filarski (2014). Characteristics at projected investment wave is based on the work by van Dorsser and Wolters (Van Dorsser et al. 2012) and author's own insights

these are ships of 85 m in length, 9.5 m in width and have a maximum draught of 2.5 m (Rijkswaterstaat 2011). The width of the canal at water surface level was around 50 m. The project included two sets of navigation locks, sluices (to allow the discharge of water into the river as needed) and pumping stations (to pump water from the river to the town of Hoven in times of water scarcity). One set was situated at the entrance to the river and the other halfway along the canal. The embankments of the canal were stabilized using rock. The canal served the region well without any significant physical changes for the 80 years that followed. Over the years cargo transportation has grown to an annual level of 15.000 ship passages, 6 million tons of cargo incl. 70.000 containers. These ships served a variety of industry, amongst these the farming community (fertilizer, agro products), a chemical plant (salt products and specialized chemicals), and a container terminal.





**Fig. 2** The Hoven Canal

### 5.2 The End-of-lifetime Dilemma—A Traditional Approach to Artificial Waterways

Around 2010, it became clear that the canal had reached the end of its technical and functional lifetime. The two navigation locks were no longer able to serve an increasing part of the country's commercial fleet as general ship dimensions kept growing. Typically in the Netherlands, many traditional local waterways have been dimensioned to CEMT class II (ship dimensions length, width, draught:  $65 \times 6.60 \times 2.5$  m) or CEMT class IV ships (ship dimensions length, width, draught:  $85 \times 9.50 \times 2.5$  m). Modern ships and nearly all of ships currently being build, however, are all of CEMT class V or larger (ship dimensions of length, width, draught:  $110 \times 11.4 \times 3.0$  m). Costs per tonne in inland navigation range from around € 5,- to € 20 euro depending on the ship size and distance of the trip. Container transport costs between € 170 and € 200 per TEU (Policy Research 2006), again depending on ships size and distance. Critical ship dimensions are usually length and width as ship captains can choose to sail with limited cargo to allow them to sail shallow waterways. In the case of the Hoven canal, reliability of operations decreased to such a point that industry was no longer willing to use the canal. Furthermore, climatological change meant that the pumping capacity no longer met demand in times of severe drought. A study showed that the most beneficial scenario would involve rebuilding the navigation locks, sluices and pumping stations. This would not only bring the system up to current standards, but would also take into account new requirements for serving the modern fleet and changed rainfall patterns. The cost was estimated at €100 million: €40 million for each of the two locks and €10 million for each combination of pumping station and dewatering sluice. It was estimated that the new system would serve the community for 100 years. The result of a cost-benefit analysis was positive, and a careful Environmental Impact Assessment was undertaken. The cost of the proposed project included mitigation and compensating measures of various kinds such as replanting of trees, reduction of noise, vibrations and dust during construction. Generally these costs are very limited in the case of navigation lock renewal as the impact is very local and similar to the old situation (if this would have been a greenfield development the impact is generally much broader). Approval seemed a formality.

### 5.3 Questions Destabilizing the Traditional Approach

The community raised critical questions. The calculations, it seems, were based on 30-year forecasts, but the new investment was supposed to cover a 100-year lifespan. How could that

be? Some people wanted to know whether farming would still be important to the region in two or three decades' time. Others asked whether the industry that required increasingly large ships would still exist in 50 years, especially given the uncertainty caused by the economic crisis. Perhaps a focus on leisure, nature or cultural heritage would be a more appealing perspective for the region.

The decision-makers were unable to answer these and related questions with any certainty. How could they know whether the new canal would aid or prevent future opportunities that might yield a far more favourable cost-benefit ratio for the region? And, from an economic standpoint, the long-term development plan placed hardly any weight on radically different, but not unreasonable, assumptions about regional developments.

#### 5.4 The Alternative Approach—A Value-Driven One

An alternative approach was consequently taken. Reducing the requirement of 2,5 m draught for shipping to 2,0 m created the possibility of a system with only one navigation lock instead of two. Vessels that are less heavily loaded but sail more frequently now serve the industry. Economies of scale in transportation reduce shipping cost per tonne, but are not necessarily optimal for the entire supply chain. Large shipments reduce some transportation cost per unit, but storage cost (dead capital) and the capital cost of unloading equipment rises as the size of the average load increases. However, the possibility of receiving large shipments can improve the negotiation power of the receiving firm.

There were also concerns about the reliability of the corridor. When storage is reduced, reliability of the supply becomes a concern. Industry therefore valued this aspect of the system. In order to enable this, the lock complex halfway along the canal was renewed, while the lock complex at the entrance to the river was removed in 2011. This was possible because the vessels' reduced draft meant that only a lock halfway along the canal was required and the one at the entrance of the canal could be removed. The reliability of the entire system doubled due to the removal of the one lock and renewal of the other. The operating and maintenance costs for the canal authority are now much lower than they used to be. Reduced economies of scale have been disadvantageous for transportation interests, but by reducing local port dues industry has been compensated.

In times of drought, water security for farmers is now more broadly framed. The issue of water supply was framed in the past as a farming issue. Over the last century, however, canal operations have become increasingly more important to a much wider group of users, whose concerns include household water, process water and cooling water. The water-dependent ecology also became a protected 'user' of the water. Given these developments, the demand for water over time is less straightforward. Restored wetlands connecting to the canal have increased the water storage capacity of the overall river system. For the canal authority it was important to align its ecosystem values with its efforts to increase water storage capacity and enhance the robustness of the water system. For the town of Hoven it was important to make the region a more attractive place in which to live or spend leisure time.

The pumping capacity was reduced because the system is far more capable of damping the extremes. This, in turn, lowered investment and maintenance costs while improving reliability (due to increased storage capability). 'Smart' irrigation methods have continued to reduce the demand for irrigation water.

In order to be able to implement all these changes, industry and farmers had to be convinced. Initially, the increased transportation costs made it hard to gain backing from industry. Furthermore, farmers were opposed due to the extra cost of investing in smart irrigation systems (to lower their demand for water). Both of these stakeholder groups initially

preferred to keep their costs down by encouraging the canal authority to invest in the renewal of the ‘old’ infrastructure. But quick calculations revealed that the benefit would increase in the long term and the cost reductions would be far greater for everyone in the region. It was only those two groups who were facing short-term drawbacks. The question was therefore how to tap the long-term benefits to the region in such a way that they could be used to compensate those who would have to pay a significant price in the short-term. Table 4 summarizes the differences between the traditional and the alternative approach.

## 6 Discussion

A question inherent to the case is whether the value-oriented management approach to the Hoven Canal produced a better outcome than the straightforward renewal of the old system would have done. Although such a question is difficult to answer entirely, the development of a more flexible approach to infrastructure investment and development does raise important issues. Decisions

**Table 4** Summary of cost and benefits of the traditional approach and alternative approach the Hoven canal

	Traditional approach		Alternative approach	
	Cost	Benefit	Cost	Benefit
Waterway authority	2 navigation locks (2×€40 million), 2 combined pumping stations/dewatering sluices (2×€10 million). Total €100 million.	None monetary. Addressing a policy goal, strengthening support for the agency.	1 navigation lock (€40 million) and 1 combined pumping station/dewatering sluice (€8 million). Total €48 million.	Reduction of operating and maintenance cost. Addressing a policy goal, strengthening support for the agency. Hydropower revenues. Reduced pumping cost due to smart irrigation by farmers. Reduced investment in pumping/dewatering station due to measures by municipality and farmers.
Industry	none	Economies of scale	Extra cost for transportation (less draught).	Reduced cost for handling and storage. Compensation by waterway authority for reduced available depth in canal. Increased reliability of transportation system
Farmers	none	none	Investment in smart irrigation equipment	Support by waterway authority from pumping cost savings. Less vulnerability at droughts.
Municipality	none	none	Development of wetlands	Support by the waterway authority due to reduced flood protection measures. Increased attractiveness of the region. Increased tax revenues through growing tourism and increased house prices.

that respond to a broad spectrum of values are likely to have greater political legitimacy. The overall cost is lower, meaning that there will probably be less political opposition than otherwise.

The interviewees confirmed that, as in the story, for many waterways the ageing of the assets and the need for their replacement is what drives investment. The new assets need to meet two conditions: the multitude of stakeholder issues has to be addressed in some way, and the requirements have changed compared with the original ones.

In the new scenario devised for the Hoven Canal, a major break was made with the traditional approach by seeking value from issue linking. Whereas a single party can only optimize within its own boundaries, multiple actors can connect issues in terms of space, time or functions and employ, create or capture value by doing so (Evers and Susskind 2009; Kabat et al. 2005; Susskind et al. 1999; Woltjer and Al 2007). Multiple actors with either conflicting or parallel interests can seek mutual gain through their differences in utility, capability, expectations and forecasts or endowments (Lax and Sebenius 1986). As the case shows, the alternative approach includes several transactions to harvest gains. A fundamental hindrance to employing these mutual gains is transaction costs (Coase 1937; Williamson 1998). Actors have to reach an agreement of some sort, which implies valuable, and for some actors very scarce, resources being deployed without any guarantee of reaching the agreement they would like.

With the Hoven Canal, by linking the problem of water quantity control to farmers and landowners for instance, more space was made available for a solution and the actors in the system did not act counterproductively because the incentives guided all actors in the same direction. This prevents one actor, the waterway authority in this case, being forced to make tremendous investments, which are, on an overall scale, far from efficient. Therefore, instead of basing investment on uncertain and unrestricted long-term demand forecasts (unrestricted because water users have no incentive to save water), investment on the both supply and demand sides needed to be optimized as a whole by linking the networks (Borgers and Van der Heijden 2011).

A way then had to be found to compensate parties who were suffering loss. By making these links between systems, the overall reduction in the cost of improving the canal was around €50 million, and this was followed by permanent reductions in maintenance and operating costs. As the farmers and industry were facing, respectively, extra investment and higher transportation costs, part of the gain made by the Canal Authority was needed to compensate these stakeholders.

New functions of the system also contributed to the solution. Couplings in the case story include the enhanced aesthetic qualities resulting from the new embankments as well as the addition of wetlands (Thorp et al. 2010). Improved reliability is another factor that has been shown to increase the value of the system. The importance of this aspect of waterways has been recognized in the Netherlands, and a nationwide programme on ‘reliability of the waterways’ (Ministerie van Verkeer en Waterstaat 2005) followed, which aims to improve this characteristic for the benefit of the users of the system. The interviewees stressed the importance of this aspect.

Different actors reaching an agreement achieved all the above-mentioned solutions. The interviewed project officers acknowledge that such an agreement could only be reached after considerable amounts of time, energy and money had been spent on the details, and yet the agreement involves different uncertainties than the actors have been used to cope with. These difficulties, referred to in economic literature as transaction costs, are key in the optimization process. Transaction-cost theory has opened up an entire economic field of exploring and analysing optimization strategies for all sorts of organizations and has proven to be a fundamental element in organizations realizing mutual gains (Coase 1937; Williamson 1979, 1998).

Transaction-cost analysis has found its way to other fields as well, including the interactions between public and private entities in the field of spatial planning (Alexander 1992, 2001). The explanatory power of transaction cost theory when it comes to creating value could therefore be of great help in addressing the problematic state of our waterways with their need for high investment demand and multi-actor context.

## 7 Conclusions

The title of the article refers to whether we need to rethink our waterways. The answer is a clear ‘yes’ for countries where the ageing of assets entails a need for reinvestment and in which the socioeconomic environment has changed. These conditions apply to many western countries that rely on a properly functioning waterway system. The end of the functional or technical lifetime of many of the capital-intensive assets in waterways, such as navigation locks, weirs and artificial embankments, consequently creates a push for such a rethink.

The Hoven canal makes clear that not all incentives to rethink the waterways arise from re-establishing the traditional function according to modern standards. Opportunities to enhance the significance of waterways for society are an important factor as well. As many waterways were traditionally developed with a narrow focus on navigation, there are opportunities to employ new values that are related to this system.

Current management practice falls short when it comes to developing these waterways to their full potential. Increasing awareness of this situation amongst practitioners could help move towards a more viable and efficient redevelopment path. The review of projects in this paper has shown that investment strategies for current waterway projects assume a broader consideration of both the physical and institutional context in which these projects operate. In particular, linkages (or couplings) between waterway values and other land-use values are imperative. A further assessment of the role of the transaction costs involved in integrating these values would be useful. Transaction-cost theory could be instrumental in revealing management strategies that are productive in employing value and generating alternative funding sources.

Finding value in cooperative strategies is a promising way forward for waterway authorities to find support and funding for those waterways that are in need of development or redevelopment. Applying a transaction-cost framework to the waterway sector could help gain an understanding of the possibilities and limitations of a value-driven strategy.

**Acknowledgments** The authors wish to thank Ford Professor Lawrence Susskind of the Massachusetts Institute of Technology for his inspiring ideas, reflections and comments. Furthermore, the authors wish to credit Bas de Leeuw and Tjeerd Burger for assisting in the interview process. Rijkswaterstaat, the Dutch agency responsible for the national highways, waterways and water system, sponsored the research.

## Appendixes

### Appendix 1: List of Interviewees

An initial round of interviews has been conducted to explore the topic. A total of nine persons, all project manager, or contract manager, have been interviewed to explore the subject and to outline further investigations. This has been the basis for a second series of interviews following the structure as given in Appendix 2. In this round 10 persons were interviewed.

Interviewees were contract managers, managers of the environs, and one technical manager. In addition two officers overseeing several waterway projects have been interviewed.

General respondents:

- Respondent A: works at the program-office of RWS and deals with inland shipping
- Respondent B: works on the DBFM Lock-program of RWS, a program of 5 locks that use a DBFM-construction

Waterway project respondents

- Respondent C: former project manager of a waterway project and currently project manager of two waterway projects
- Respondent D: current environs manager of the project
- Respondent E: current assistant environs manager of a project
- Respondent F: former project manager of a project
- Respondent G: current environs manager of a project
- Respondent H: former project manager of a project
- Respondent I: current environs manager of a project
- Respondent J: former technical manager of a project

## Appendix 2: Structure of the interview

### Opening:

How would you 'sell' the project?

Could you explain briefly the motivation for the project?

Could you describe the decision making process for the project?

### General view

How was the project viewed initially by RWS?

Were there any other visions for the project at that moment?

Was there an integrated vision which became a guidance for the development process?

### Cooperation

How were stakeholders involved?

What role did the public participation process play?

How would you describe the relationship with stakeholders?

Which players did eventually determine the solution/design?

### Cooperation government

How did the cooperation with municipality and province develop?

Could they have been the initiator of the process as well?

### Value creation

Were interests of stakeholders opposing or reinforcing?

Has value creation actively been pursued?

Were there any value opportunities for private parties in the contracting phase of the project?

### General developments waterway projects

Did any noticeable changes take place in this sector/market with regard to lock projects?

Is society more unpredictable than is used to be years ago?

How does RWS address uncertainty, unanticipated events and multitudes of interests related to waterway projects?

(a list of topics covering people, planet and profit is shown to determine to which extend topics played a role and have been addressed in the project)

### Integrated approach

What do you view as an 'integrated' approach?

Is, in your view, such an approach stimulated by your organisation?

Does such an approach increase the value?

### Closing question

If you could do this project all over again, what would you do differently?

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